METHOD AND APPARATUS FOR PRIORITIZING PRINT JOBS FROM MULTIPLE PRINTER INPUT CHANNELS

FIELD OF THE INVENTION

This invention relates in general to printing systems, and more particularly to a method and apparatus for prioritizing the order in which print jobs received over multiple data channels are printed.

BACKGROUND OF THE INVENTION

Desktop computers and computer networks are usually connected to various peripheral devices to extend the computer's capabilities. One common peripheral device is a printer, which produces text and images in hardcopy format. There are many different types of printers, broadly grouped into impact printers and non-impact printers. Printers may also be categorized by the environment under which they operate, such as local and network printers. A local printer is one that is directly connected to one of the ports on a desktop, workstation, or other single host computer, and a network printer is shared by multiple computers over a network.

Local printers receive print data from a source, such as a single host computer, and network printers receive print data via a network that contains at least one host computer or network server. In typical desktop personal computer (PC) environments, "print jobs" are submitted (via the direct connection or network) to the printer, as a means to pass the print data to the printer. Print jobs represent units of

work to be run on a printer, and can include printing one or multiple files, depending on how the print jobs are requested. In single host environments, and particularly in network environments, a connected printer may be presented with a large print file or multiple print files by way of the print jobs. Generally, the printer is equipped with

5   sufficient memory to accept large or multiple print jobs, thereby freeing the computer to continue normal operations by allowing the printer to retain the print jobs until they are physically printed. Alternatively, print spooling may be employed which includes a program or device that controls the flow of print data to the printer, and generally stores the programs in an organized manner on a hard disk until the

10   printer becomes available.

Network printers may include multiple data channels, which are physical or logical attachments, through which print jobs can be received by the network printer. These data channels represent any printer input configuration, i.e., methods of printing, examples of which include LPD (a printing protocol of TCP/IP),

15   IPP (internet print protocol), and the like. Each of the multiple data channels may present print jobs for printing, and more than one data channel may present a job at the same time.

While multiple data channels may be associated with a printer, the printer can only print one job at a time. Traditionally, where multiple print jobs from

20   one data channel or multiple data channels are pending, the print jobs are printed in the order in which they are received. Therefore, where one data channel is associated with high priority print jobs, these high priority jobs might have to wait behind many lower priority jobs associated with other data channels. For example,

in a particular computing environment, print jobs submitted over a TCP/IP LPR data channel may be considered higher priority than print jobs submitted over a different type of data channel. In such cases, it is undesirable and inefficient to force the higher priority print jobs to be held in abeyance while the lower priority print jobs

5 consume valuable printer resources.

In view of the sophistication of modern day printers and the increasing use of multiple data channels associated with network printers, it would be desirable to avoid these and other problems associated with prior art systems for printing multiple print jobs. A need exists in the printing industry for a system and manner of

10 governing the order that print jobs from multiple data channels will be printed. The present invention provides a solution to the aforementioned and other shortcomings of prior art printing systems, while offering additional advantages over the prior art.

SUMMARY OF THE INVENTION

To overcome limitations in the prior art described above, and to overcome other limitations that will become apparent upon reading and understanding the present specification, the present invention discloses a system, apparatus and method for prioritizing the order that print jobs received over multiple data channels are printed. Multiple data channels associated with the printer are each assigned a priority value, such as by a system administrator or other authorized user, and each print job received via a data channel adopts the priority value associated with the data channel from which the respective print job was received. In this manner, print job priority can be imparted to print jobs immediately upon their arrival to the printer.

In accordance with one embodiment of the invention, a method is provided for dictating the order that print jobs received over multiple data channels are printed. The method includes assigning a priority value to each data channel that receives print jobs. The priority value of the data channel is imparted to each of the print jobs received via its respective data channel. The print jobs are printed in an order corresponding to their associated priority values.

In accordance with another embodiment of the invention, a printing device is provided to receive and print jobs transmitted by computing devices. The printing device includes a plurality of data channels to receive the print jobs. Each of the data channels is assigned a priority value, and each of the print jobs received at the data channels assumes the priority value of its respective data channel. A compare module receives the priority values corresponding to each of the received

print jobs, and identifies the print job exhibiting the highest priority. A print engine prints the print jobs in the order from the highest priority to the lowest priority. In accordance with another aspect of the invention, the printing device is used in connection with a network, where multiple computers are arranged in a network, and

5   the computers transmit print jobs over the network. The printing device is also coupled to the network to receive and print the print jobs transmitted by the computers.

According to another embodiment of the invention, a computer-readable program storage medium that embodies a program of instructions

10   executable by a print server system to process print jobs is provided. The program of instructions allows a priority value to be assigned to each data channel that receives print jobs. The program associates the priority value assigned to each data channel with each of the print jobs received at its respective data channel. The relative priorities of each of the print jobs is determined, based on its associated

15   priority value. The program governs printing of the print jobs in a sequence corresponding to the relative priorities associated with each of the print jobs.

These and various other advantages and features of novelty which characterize the invention are pointed out with particularity in the claims annexed hereto and form a part hereof. However, for a better understanding of the invention,

20   its advantages, and the objects obtained by its use, reference should be made to the drawings which form a further part hereof, and to accompanying descriptive matter, in which there are illustrated and described specific examples of an apparatus in accordance with the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in connection with the embodiments illustrated in the following diagrams.

Fig. 1 is a block diagram illustrating a portion of a printing device

5   incorporating the principals of the present invention;

Fig. 2 is a flow diagram illustrating one embodiment for dictating the order in which print jobs are printed in accordance with the present invention;

Fig. 3 is a block diagram illustrating an internal print data channel in accordance with one embodiment of the invention;

10   Fig. 4 is a flow diagram of a particular embodiment for dictating the order that print jobs are printed in accordance with the present invention;

Fig. 5 is a block diagram illustrating an example in which the assignment of data channel priorities results in printing print jobs in an order dictated by the data channel priorities; and

15   Fig. 6 is a block diagram of an example computing arrangement that can be used in connection with software, firmware and other computer programs to carry out the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description of the exemplary embodiment, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration the specific embodiment in which the invention may be

5 practiced. It is to be understood that other embodiments may be utilized, as structural and operational changes may be made without departing from the scope of the present invention.

Generally, the present invention is directed to a method and apparatus for dictating the order in which print jobs received over multiple data channels are

10 printed. Multiple data channels associated with the printer are each assigned a priority value, and each print job received via a data channel adopts the priority value associated with the data channel from which the respective print job was received. In this manner, print job priority can be imparted to print jobs immediately upon their arrival to the printer.

15 Fig. 1 is a block diagram illustrating a portion of a printing device 100 incorporating the principals of the present invention. Print data is provided to the printing device 100 via a "print job," which is a unit of work to be run on a printer. A print job may include only one file, or multiple files, depending on how the print job is requested. The system assigns a unique job number to each print job it runs as a

20 means to identify the print job.

The printing device 100 includes one or more physical or logical attachments over which print jobs are received. Examples of attachments include Ethernet, Twinax, Parallel ports, despooling components and others. Attachments

represent a subset of a more abstract entity referred to as a "data channel," such as data channels 102, 104 and 106. Print jobs 112, 114 and 116 are provided to the multiplexer component 120 via data channels 102, 104 and 106 respectively, where the data channels represent any printer input configuration, i.e., methods of printing.

5   The protocol stacks 107, 108, 109 represent the modules or operations for passing the print job from the physical layer to the appropriate protocol layer, depending on the particular physical layer and protocol employed (e.g., TCP/IP, parallel port, etc.). Any number of different data channels may be employed in connection with the present invention.

10   One task of the multiplexer component 120 is to manage logical connections between data channels and the multiplexer output paths. The multiplexer 120 may perform various functions for the disposition of a new print job. It may direct incoming print data to a multiplexer output path for the print engine 122 for immediate printing, or may direct the print data to a multiplexer output path for a

15   spooling module 124. A storage medium, such as hard disk 126, may be provided to operate in connection with such a spooling module 124. A spool (Simultaneous Peripheral Operation On Line) module generally represents a program or device that controls the flow of data to an outputting device such as a print engine 122. Spooling allows a user to send a print job as a file to the hard disk 126, where it can

20   be queued for printing by the print engine 122.

        The multiplexer 120 may also signal the data channels to suspend the receipt of additional print data until that data can be processed. The connection between the data source (e.g., data channels) and the data sink (e.g., print output

paths) is managed such that no more than one data channel has access to the print engine at a time. If the spooling feature is present, the multiplexer 120 manages the logical connection from the data channels 102, 104, 106 to the spooler 124.

The spooler 124 is the front end process to a despooling process that

5   reads print data from the hard disk 126 and passes the print data through the multiplexer component 120 to the print engine 122. Upon initialization of the printer 100, the hard disk 126 is formatted with a "spooler" directory. In this manner, a certain amount of disk space is allocated for the spooler directory. Initialization is performed upon power up or "boot up" of the printer, or alternatively may be

10   performed via express designation of an initialization command or other specific action.

One operation of the spooler process is to manage incoming print job requests. The spooler manages various operations, including the spooling of new print jobs. The spooler 124 also makes status changes to print jobs in a "job monitor

15   table" 150. More particularly, the spooler component 124 effects function calls that the multiplexer component 120, and other entities of the controller, use to send new print jobs. These additions and other status updates to these print jobs are maintained in various status modules, including the job monitor table 150 and a job description file (JDF). The job monitor table 150 stores information relating to all of

20   the spooled, currently spooling, and currently despooling print jobs for the spooler component 124. The information about each of these spooled, currently spooling and currently despooling print jobs is also stored in the JDF for persistence purposes over printer power cycles.

The JDF is a job description file that includes data relating to the specific print job. The job monitor table 150 includes fields corresponding to fields in the JDF, and the JDF is used to resurrect the job monitor table 150 in the event of a power cycle or other power loss to the printer. In this manner, jobs in the print

5 queue will be preserved over power cycles of the printer. The despooler, upon initialization of the printer, reads each of the JDF files and informs a job monitor task to create an entry in the job monitor table 150 for these print jobs. When a new job is sent to the spooler, a new JDF will be created and written into the JDF directory. In one embodiment, the fields of the JDF and job monitor table are corresponding

10 fields, and thus reference to the JDF and job monitor table may be used interchangeably for purposes of this description.

An example of the contents of such a JDF file is shown in Table 1 below:

jobid	The job ID of the spooled job
jobstatus	Denotes if the data file in the print directory was 0 (being written to disk), 1 (successfully written to disk), or 2 (unsuccessfully written to disk)
bytesspooled	Denotes the total number of bytes that have been spooled to the data file for this job in the print directory
commandflag	Denotes whether to 0 (print), 1 (hold), 2 (print and hold this job), or 3 (cancel)
copies	Denotes the number of copies the despooler PCM will produce to the multiplexer
format	Denotes whether to 0 (not format), 1 (format PDF to PS this file through the despooler PCM)
pcmid	Denotes the ID of the PCM that this job came in on
pcmpriority	Denotes priority of the PCM that this job came in on
pcmpersonality	The personality of the PCM that the job came in from
userhost	Denotes the user and/or host that sent this job to the printer
title	Denotes the title of this job to be printed

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Table 1

Referring to Table 1, one of the fields stored in the job monitor table

150 and JDF is a "pcmpriority" field, which records the priority of the data channel

that the particular print job was input to the printer 100. As will become more

5   apparent below, this priority value reflects the priority assigned to the print job as a

result of being input to the printer 100 via a particular one of the data channels 102,

104 through 106.

As can be seen in Fig. 1, the present invention allows priorities to be

assigned to each user-accessible data channel, such as data channels 102, 104

10   through 106. These priority assignments to the data channels are represented by

priority A (PR-A) 132, priority B (PR-B) 134, and priority n (PR-n) 136. When a

priority has been assigned to a data channel in accordance with the present

invention, print jobs associated with that data channel take on the corresponding

assigned priority. For example, print job(s) 112 is received by the multiplexer

15   component 120 via data channel 102 which, in the illustrated embodiment, is

assigned a first priority PR-A 132. This results in the priority PR-A being associated

with that particular print job, as represented by PRINT JOB + PR-A 142. Similarly,

print job(s) 114 is received via data channel 104, resulting in the priority PR-B being

associated with the print job (i.e., PRINT JOB + PR-B 144), and print job(s) 116 is

20   received via data channel 106, resulting in the priority PR-n being associated with

the print job (i.e., PRINT JOB + PR-n 146). Each data channel in the system thus

assigns its respective priority value to the print jobs passing through that data

channel. In one embodiment of the invention, the "pcmpriority" field of the job

monitor table 150 and the JDF, as shown in Table 1 above, maintains the priority

value corresponding to the data channel in which the particular print job was received.

Referring now to Fig. 2, a flow diagram is provided illustrating one embodiment for dictating the order in which print jobs are printed in accordance with

5   the present invention. Each of the multiple data channels may present print jobs for printing, and more than one data channel may present a print job at the same time. However, the printer can only print one job at a time. The first data channel to present a print job to an idle printer is selected for printing. Data channels that present print jobs when the printer is busy must wait until the printer is free. The

10   present invention provides the ability for the printer to apply prioritization to print jobs that are waiting for the printer.

A priority value is assigned to each data channel associated with the printer that receives print jobs, as illustrated at operation 200. In one embodiment, each data channel is assigned a different priority value. A different numeric priority

15   is assigned to each user-accessible data channel, although alpha, alphanumeric, ASCII, or other indicia capable of order recognition can also be used instead of a numeric priority representation.

In this manner, jobs submitted over a particular data channel, such as a TCP/IP data channel, can be given priority over jobs arriving over another data

20   channel. This also allows the printer to order the printing of internally-generated print jobs such that they are given a higher priority than any user-submitted print job, so that internally-generated print jobs are printed immediately when the printer is idle, or immediately following the current job when the printer is busy. Internally-

generated job printing is described in greater detail below.

The priority value assigned to each data channel is then associated with each of the print jobs received via that data channel, as illustrated at operation 202. For example, all print jobs related to the TCP/IP data channel would receive

5 the priority assigned to that data channel, such as a priority of 5 where the possible priority values range from 1-9. The print jobs are printed 204 in the order corresponding to these associated priority values. For example, where a print job relating to a data channel having a priority of 3 and a print job relating to a data channel having a priority of 5 are waiting for the printer, the print job relating to the

10 data channel having a priority of 3 is printed prior to the print job that was received via the data channel having a priority of 5 (assuming the print priority increases as the priority value decreases). In this manner, printing is accomplished in an order that depends on which data channel the print jobs are received.

As previously described, a data channel in accordance with the

15 present invention may include an internal print data channel 300 as illustrated in Fig. 3. The internal print data channel 300, like other print channels, provides a conduit to the multiplexer component, and ultimately to the print engine or spooler, for particular print jobs. The internal print data channel 300 facilitates printing of internally-generated print jobs, such as the printer configuration page 304, the

20 printer demonstration (demo) page 306, and the like. An internal print module 308 recognizes the user input, and performs the appropriate function in response thereto.

Internally-generated print jobs are initiated by a user via a user

request, which in one embodiment is initiated via a user interface 302. In one

embodiment of the invention, the user interface 302 includes one or more manually-

activated buttons resident on the printer device itself. Selection of a particular

internally-generated print job, such as printing a printer configuration page or a print

5 demo page, is thus initiated by pressing a button corresponding to the desired

function. The user interface 302 may also include a graphical user interface (GUI)

that displays a selectable list of available internally-generated print jobs on a display

device, or alternatively may include other forms of user interfaces, including text

entry, voice activated input, touch screens, etc.

10   In one embodiment of the present invention, the priority for the internal

print data channel is set to zero (0), thus making it the highest priority data channel

available in this embodiment. Another embodiment of the invention permanently

sets the internal print data channel to a priority of zero, thus making this default

setting unavailable to a printer administrator. In this case, the priority associated

15 with the internal print data channel cannot subsequently be reset to a different

priority value.

    Referring now to Fig. 4, a flow diagram is provided of another

embodiment for dictating the order that print jobs are printed in accordance with the

present invention. Multiple data channels are provided 400 for a printing device to

20 receive print jobs. In one embodiment, each data channel is associated with a

predefined group of print job types, such as those arriving via the parallel port,

TCP/IP port, etc. In one embodiment, one data channel corresponds to internally-

generated print jobs as described in connection with Fig. 3. A priority value is

assigned 402 to each data channel. The priority value can be assigned upon initialization according to a predetermined priority schedule, or can be assigned/reassigned via a user interface by a printer administrator. In one embodiment of the invention, priority values 1-9 can be assigned to the data

5 channels, where 1 is the highest priority and 9 is the lowest priority. In another embodiment, the data channel corresponding to the internally-generated print job is given the highest possible priority, such as priority value zero (0). In this manner, internally-generated print jobs will be printed before any other user-submitted print job. Each of the data channels may be assigned a different priority. Alternatively,

10 one or more of the data channels may be assigned like priority values, in which case printing priority will be awarded to the like-priority print job that arrived first.

Print jobs are received via the data channels as illustrated at operation 404, and the priority of the data channel is associated 406 with each of the print jobs received via that data channel. The priority value for each print job may be stored

15 408. If the printer is idle as determined at decision operation 410, a print job received at any data channel can be immediately printed 412. If the printer is not idle, but only one print job is pending as determined at decision operation 414, the pending print job will be printed 416 when the printer becomes available (i.e., completes the print of the currently-printing job). If multiple print jobs are pending,

20 the relative priorities of the multiple pending print jobs is determined, as illustrated at operation 418. Where more than one print job is determined to have the currently-highest priority as determined at decision operation 420, the one of these print jobs that arrived first will be printed first, as illustrated at operation 422. In this case, a

time of arrival may be monitored, or alternatively the print jobs having a common

priority value can be managed in a first-in-first-out queuing arrangement. Otherwise,

where the highest current priority value applies to only one pending print job, that

print job having the highest priority will be printed 424.

5   Fig. 5 is a block diagram illustrating one manner in which the assigning

of data channel priorities results in printing print jobs in the order dictated by the

data channel priorities. Three data channels are illustrated, including data channel

500 having been assigned a priority value of 0, data channel 502 having been

assigned a priority value of 4, and data channel 504 having been assigned a priority

10   value of 7. In this example, data channel 500 represents the internal print data

channel, and has the highest priority possible.

Status information for the print jobs from each of the data channels is

stored in the job monitor table 506. For example, status information for Job-1 from

data channel 504 is stored at job monitor entry 508. Status for Job-2 is stored at job

15   monitor entry 510, and status for Job-3 is stored at job monitor entry 512. As seen

in Fig. 5, Job-1 at entry 508 is associated with PCM priority-7, Job-2 at entry 510 is

associated with PCM priority-0, and Job-1 at entry 512 is associated with PCM

priority-4. The PCM priority field 514 was described above in connection with Table

1 as the "pcmpriority," which records the priority of the data channel that the

20   particular print job was input to the printer.

The data channel priorities in field 514 can be compared at compare

module 516 to determine the appropriate priority of the print jobs. In the current

example, priority-0 is higher than priority-4, and both are higher than priority-7.

Therefore the priority of jobs in the print queue 518 is (1) Job-2; (2) Job-3; and (3) Job-1. The print jobs will be sent to the print engine 520 in the order of their relative priorities.

The compare module 522 represents another embodiment of the
5   invention, where priorities for the print jobs are determined, and the print jobs are stored on the print queue 518. In such an embodiment, the PCM priority field 514 of the job monitor table 506 stores the priority to maintain the proper status of each print job. The compare module 522 can perform the print job priority comparison as the jobs are input via their respective data channels, and then appropriately queued
10   by priority in the print queue 518. The job monitor table 506 in this embodiment stores the priority for each print job in the PCM priority field 514 as status information.

It should be recognized that the print queue 518 represents a logical entity, and print jobs may be ordered on the print queue 518 in the order in which
15   they will ultimately be printed. Alternatively, print jobs may be placed on the print queue 518 in any order, but pulled off of the print queue 518 in an order corresponding to the assigned priority for the print jobs.

The invention allows a printer administrator to set the print job priorities to any value in a predefined range of possible priority values. This provides printer
20   administrators additional control over the order in which print jobs are printed. The administrators granted such control can access operations that facilitate assignment of a priority to each data channel. Printer administrators are typically granted certain "rights" over other users, and in accordance with one embodiment of the present

invention, only administrators are granted the right to assign or reassign priorities to data channels. Users having lesser privileges would then be unable to avail themselves to the data channel priority assignment operations that are available to the administrators.

5   Administrators or users having the proper rights can therefore access operational modules, such as computer programs, firmware, hardware or some combination thereof, to facilitate assignment of a priority to each data channel. The operational modules can be resident in the printing device or an external computing device coupled to the printing device. Administrators or other users may gain

10   access to such operational modules upon proof of ownership of the requisite rights, such as entry of a system password to the administrator account or other permission requisite. This access may be provided via a user interface to the operational modules, where the administrator or user enters the desired data channel priorities therefrom. Generally, manners for allowing administrators to interface to privileged

15   operational modules are known to those skilled in the art, and any such manner may be used without departing from the scope and spirit of the invention.

Hardware, firmware, software or a combination thereof may be used to perform the aforementioned operations. The functional modules used in connection with the invention may reside in a computing device, such as a print server, or the

20   functional modules may perform these print server activities as resident modules on the printing device itself. An example computing structure that can be used in connection with firmware and other computer programs to carry out the present invention is illustrated in Fig. 6.

Referring now to Fig. 6, a system block diagram of a example print

server system 600 is shown, in which the principles of the present invention may be

applied. A computing arrangement suitable for performing the print server functions

in accordance with the present invention typically includes a central processor

5   (CPU) 602 coupled to random access memory (RAM) 604 and read-only memory

(ROM) 606. The processor 602 may communicate with other internal and external

components through input/output (I/O) circuitry 608 and bussing 610. The

computing arrangement 600 may also include one or more data storage devices,

including hard and floppy disk drives 612, CD-ROM drives 614, and other hardware

10   capable of reading and/or storing information. In one embodiment, software

containing job control applications, such as line printer daemons for carrying out the

present invention, may be stored and distributed on a CD-ROM 616, diskette 618 or

other forms of media capable of portably storing information. These storage media

may be inserted into, and read by, devices such as the CD-ROM drive 614, the disk

15   drive 612, etc. The software may also be transmitted to the computing arrangement

600 via data signals, such as being downloaded electronically via a network such as

the Internet. The computing arrangement 600 may also include a display 620, a

user input interface 622 such as a mouse or keyboard, and one or more printers

624. As previously indicated, the computing arrangement 600 may be embedded

20   within the printer 624 itself. External print jobs are generally provided to the

computing arrangement/print server 600 via I/O ports 626. Print jobs originating

from the print server 600 itself may also be provided to the printer(s) 624. The

computing arrangement 600 may optionally be connected to other network servers

628 in an intranet or local network configuration. The computer may further be part of a larger network configuration as in a global area network (GAN) such as the Internet. In such a case, the computer accesses one or more web servers 630 via the Internet 632. Computing modules as described herein may reside on a print

5   server connected to the printer(s), or alternatively may be embedded in whole or in part within the printer itself.

Using the foregoing specification, the invention may be implemented as a machine, process, or article of manufacture by using standard programming and/or engineering techniques to produce programming software, firmware,

10   hardware or any combination thereof.

Any resulting program(s), having computer-readable program code, may be embodied within one or more computer-usable media such as memory devices or transmitting devices, thereby making a computer program product or article of manufacture according to the invention. As such, the terms "article of

15   manufacture" and "computer program product" as used herein are intended to encompass a computer program existent (permanently, temporarily, or transitorily) on any computer-usable medium such as on any memory device or in any transmitting device.

One skilled in the art of computer science will easily be able to

20   combine the software created as described with appropriate general purpose or special purpose computer hardware to create a computer system and/or computer subcomponents embodying the invention, and to create a computer system and/or computer subcomponents for carrying out the method of the invention.

Thus, in accordance with the present invention, a system and method is provided for allowing the printer to apply prioritization to print jobs received via multiple data channels. The present invention should not be considered limited to the particular examples described above, but rather should be understood to cover

5   all aspects of the invention as fairly set out in the attached claims. Various modifications, equivalent processes, as well as numerous structures to which the present invention may be applicable will be readily apparent to those of skill in the art to which the present invention is directed upon review of the present specification. The claims are intended to cover such modifications and devices.

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